Sand and Gravel Pit Rehabilitation in Northern Ontario

Prepared for the Aggregate Resources Section, Land Management Branch, Ontario Ministry of Natural Resources by R.J. MILLER and E.E. MACKINTOSH

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Cover. *Left: Crop of clover grown on rehabilitated pit site. Top right: Pit rehabilitation at the Leslie M. Frost Natural Resources Centre, Dorset. Bottom right: The same pit site at Dorset after rehabilitation. Part of the pit has been left in its unrehabilitated state to illustrate conditions prior to restoration of the site.*

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Introduction

In 1984, over 13 million tonnes of sand and gravel were produced in northern Ontario, chiefly for use in the construction, maintenance and repair of roads and highways. Over 3 million tonnes of stone were produced from rock quarries, which are limited in number in northern Ontario. Supplying mineral aggregate for construction in northern Ontario involves the establishment and operation of pits and quarries to remove this material from the ground. Pits and quarries are generally located as close as possible to the area of use, in order to minimize transportation costs.

In recent years, an increasing concern has developed in northern Ontario for the proper management of the environment, especially as it relates to the use of non- renewable resources such as sand and gravel. It is increasingly recognized that extraction of these resources represents only a temporary land use feature.

The art of rehabilitation is well advanced in Ontario. Many excavated sites across the province have been successfully restored, to various agricultural uses, to forest or natural areas, to fish and wildlife habitat, to recreational areas, and to urban building sites (see Selected References, Appendix 1). Many sand and gravel sites are so well rehabilitated that they are not recognizable as former pit areas, but blend in with the surrounding landscape.

Generally speaking, the rehabilitation of rock quarries is a more complicated process than the rehabilitation of sand and gravel pits. It involves specialized techniques and equipment, and must be carried out on an individual, site-specific basis. It is beyond the scope of this publication to deal with techniques for the rehabilitation of the few quarries that do exist in northern Ontario.

Figure 1. *Steep pit slopes left unvegetated can have serious erosion problems.*

Figure 2. *Ministry of Transportation and Communications extraction site in northwestern Ontario.*

Government Regulations and Policy

The establishment and operation of pits are governed by provincial legislation and policy. The following is a synopsis of legislation and policy pertinent to the extraction and rehabilitation of aggregate deposits in northern Ontario.

Figure 3. *Signing of a rehabilitated pit is sometimes necessary in high public use areas, in order to prevent trespass, vandalism or further extractions.*

MINING ACT

The Mining Act requires the issuance of a quarry permit to remove any mineral aggregate, including sand and gravel, from Crown land across northern Ontario. Quarry permits are generally issued on an annual basis by the local District Offices of the Ministry of Natural Resources, upon receipt of the appropriate application from an individual or company desiring to remove sand and gravel from Crown lands. In 1985, approximately 1500 quarry permits were issued in northern Ontario. Quarry permits may contain, at the discretion of the District Manager, provision for the rehabilitation of the extracted pit or quarry, in accordance with this Act and the Ontario government's Mineral Aggregate Resources Policy Statement.

MINERAL AGGREGATE RESOURCES POLICY STATEMENT

This policy statement, issued under Section 3 of the Planning Act, establishes priorities for the planning of aggregate resources anywhere in the province, and includes provisions for minimizing the adverse effects of aggregate extraction on the environment. The policy states that:

> "The Ministry of Natural Resources, within the context of its mandate to manage mineral aggregate resources at the provincial level shall:....

- encourage the concept of extraction as an interim land use activity. Toward this end the Ministry shall:....
- encourage sequential land use and progressive and ultimate rehabilitation with the active extraction area limited to a minimum practical size;
- encourage operation of the site in a manner as compatible as possible with surrounding land uses and activities;
- encourage all depleted extractive sites, including wayside pits and quarries, to be returned to a condition suitable for an acceptable after use and compatible with adjacent land uses".

BEACH PROTECTION ACT

The Beach Protection Act regulates the taking of any sand and gravel from the bed, bank, beach, shore or waters of any lake, river, or stream, or from any bar or flat in these waters, on both public or privately owned lands. A licence is required for extraction under this Act, issued by the local District Office of the Ministry of Natural Resources.

PLANNING ACT

Within certain areas of northern Ontario, The Planning Act governs the use of land, through delegation of responsibility for land use planning to municipalities. Official plans and zoning by-laws are the primary planning tools used by municipalities to control land uses within their boundaries. Rehabilitation must be addressed in these official plans. Various provincial government policies, including the Mineral Aggregate Resources Policy Statement (discussed previously) and the Food Land Guidelines, must be taken into consideration in drawing up municipal zoning by- laws with respect to pits and quarries. The Planning Act does not apply to actions taken by the Crown on Crown land within municipalities. The Crown will, however, consult with, and consider the planning policies of the municipality concerned.

MUNICIPAL ACT

Under the Municipal Act, municipalities may regulate the operation of pits and quarries within their boundaries. Discussion with the Ministry of Natural Resources prior to the drafting of such regulatory by-laws is advisable.

FOOD LAND GUIDELINES

In agricultural areas of the north, the Food Land Guidelines must be considered when aggregates are to be extracted on lands classified as arable cropland, Classes 1 to 3 in the Canada Land Inventory soil capability classification for agriculture. The Food Land Guidelines recognize that it is possible to restore extracted sand and gravel pit areas to agricultural use, and specify that such rehabilitation should occur, substantially to the same acreage and soil capability as existed before extraction took place.

PITS AND QUARRIES CONTROL ACT

In certain parts of northern Ontario the Pits and Quarries Control Act regulates and controls the operation of pits and quarries, and requires their rehabilitation, through a licensing process for private lands. This Act applies at the present time to most of southern Ontario, but also includes the Regional Municipality of Sudbury, the City of Sault Ste. Marie, and Great and Little La Cloche Islands. A pit or quarry licence on private lands cannot be issued in these areas in contravention of a municipal official plan or zoning by-law. The licence must be accompanied by a site plan which describes the operation of the pit or quarry and includes detailed plans for the rehabilitation of the site.

ENVIRONMENTAL PROTECTION ACT

The Environmental Protection Act, administered by the Ministry of the Environment, looks at minimizing the impacts of man's actions on the environment. This includes surface and ground water impacts, dust, noise and vibration, air quality, incompatible or conflicting land uses, soil contamination, and site drainage impacts.

Approaches to Rehabilitation in Northern Ontario

In 1985, sand and gravel was extracted from well over 1500 pits in northern and central Ontario (Ministry of Natural Resources Algonquin, Northeastern, Northern, North Central, and Northwestern Administrative Regions) (Figure 4). Many former sand and gravel pits in the north have been successfully rehabilitated, after the aggregate supply from these pits had become exhausted. Rehabilitation techniques vary from place to place across northern Ontario, dependent primarily upon the final after use of the pit site, and the quantity and quality of topsoil overburden present. Private operators, the Ministry of Natural Resources and the Ministry of Transportation and Communications have carried out successful rehabilitation projects throughout the north. The following describes a sampling of projects from each M.N.R. region, the problems encountered, approaches taken, and the results achieved. Most of these projects took place on Crown land.

Figure 4. *Ministry of Natural Resources Regions Map.*

ALGONQUIN REGION

The Algonquin Region has established a set of guidelines related to gravel pit rehabilitation. The stated purpose of rehabilitation in this Region is to restore gravel pit areas to their original use or condition, or to change these areas to a use or condition compatible with surrounding land uses. Rehabilitation involves four tasks:

- levelling the pit area to an elevation above the water table;
- reducing slopes to a maximum gradient of 2:1;
- seeding slopes to prevent surface erosion; and,
- the planting of tree seedlings.

Prior to rehabilitation work getting under way in the Algonquin Region, a preliminary sketch or plan is drafted outlining the work to be completed. Cleaning of the site, levelling, grading, and topsoil spreading is carried out using a small bulldozer, preferably with a six-way blade. Machine time averages 25 to 35 hours per hectare. Slopes are fertilized and seeded with a grass mixture to prevent erosion. In some cases the site is planted using M.N.R.- supplied red pine, white pine, and some cedar seedlings. Rehabilitated Crown pits are also fenced with snow fence and posted to discourage any further intrusions. After-uses of the rehabilitated pits in this Region include timber production and temporary, vegetated openings used by wildlife. In regards to this latter use, at least one pit in the Region has been rehabilitated in connection with an M.N.R. District deer yard management program.

The Ministry of Natural Resources has also developed a demonstration rehabilitation project in the Algonquin Region at Dawson Ponds, located at the Leslie M. Frost Natural Resources Centre near Dorset. This 25-year-old pit was rehabilitated in 1980 to provide an example of good pit rehabilitation to the aggregate industry and to the general public. Part of the pit area has been left unrehabilitated to illustrate conditions prior to treatment. These conditions included steep slopes (1:1), lack of vegetation, surface erosion, and limited topsoil. With proper grading, spreading of topsoil which had been stored for 10 to 15 years in piles at the edge of the pit, fertilization, and seeding with a rye/fescue/clover/grass mixture, good success was achieved. Trees (primarily white pine) were also planted to ensure long-term compatibility with surrounding land uses.

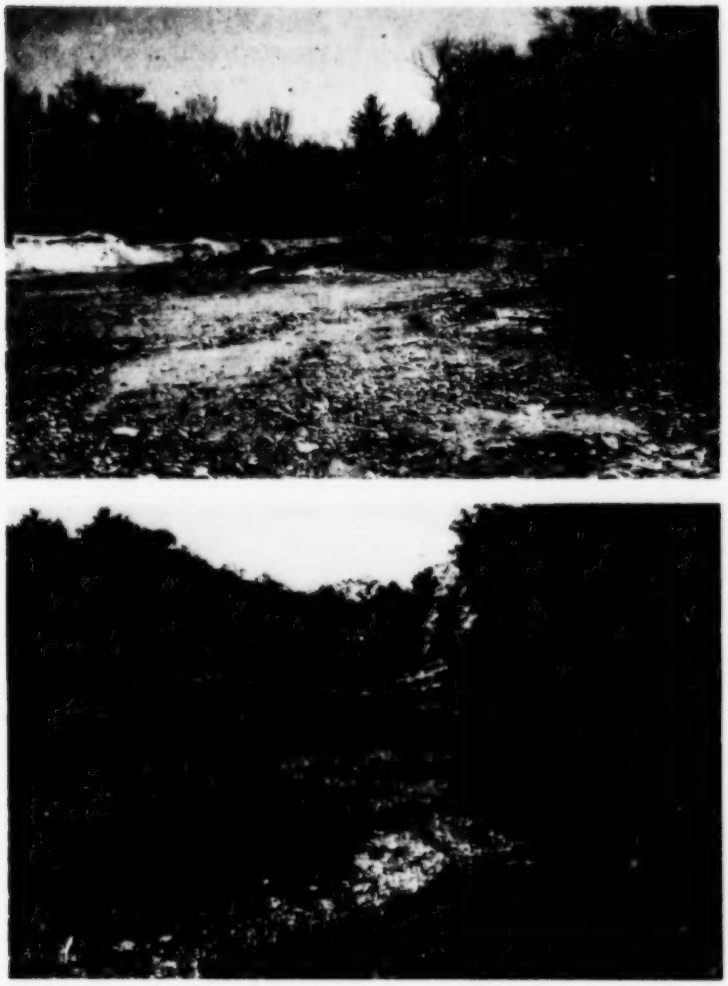

Figure 5. *Illustration of conditions prior to and after rehabilitation treatment, Leslie M. Frost Natural Resources Centre, Dorset, Algonquin Region.*

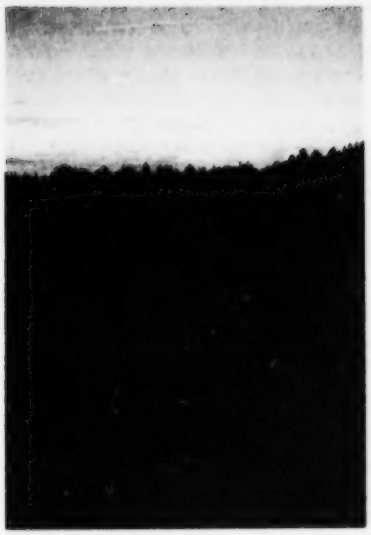

Figure 6. *Rehabilitation to agriculture, Northeastern Region.*

NORTHEASTERN REGION

Pit rehabilitation projects in the Northeastern Region encountered a wide range of conditions, from sandy sites in forested areas, to clayey sites adjacent to agricultural lands and located within urban areas. Rehabilitation techniques include the grading of the land to reduce slopes to a maximum gradient of 2:1, and preferably to 3:1 or less. The land is also cleared of debris, sloped for proper drainage, and stockpiled topsoil is spread over the pit area with a bulldozer. Machine time for grading and spreading averages approximately 30 hours per hectare. The area is then fertilized and seeded with a grass/legume mixture, and may be covered with a mulch of hay or straw. This mulch acts to prevent erosion while the planted grasses are beginning to grow, and provides a long-term source of organic matter to aid in vegetation establishment. Sites to be rehabilitated to forestry purposes are usually planted with jack pine. Within municipal boundaries, hydroseeding has been used for rehabilitation purposes. Former pits here may revert to an agricultural use, and have been used for urban development.

NORTHERN REGION

Rehabilitated pits in the Northern Region often are used for recreational areas or to improve the appearance of highway corridors. Soils in these pit areas vary from sands to clay loams, but, unlike other regions in the northern part of the province, the overburden found between the topsoil and the aggregate deposit is often quite deep. With a wide range of soil textures and differences in overburden depths, equipment times here for topsoil spreading and grading can vary significantly from pit to pit. The sandier

Figure 7. *Very bouldery site cleaned, graded, levelled, and ready for seeding, Northern Region.*

sites usually have a shallow overburden layer, and are easy to work with small or medium bulldozers. Sites in the Great Clay Belt, however, can have up to 20 metres of overburden present. Consequently, equipment time for grading ranges from 8 to 34 hours per hectare.

Rehabilitation in the Northern Region has involved the clearing of the pit area to remove all debris, including standing and fallen trees at the pit edge. The pit area is then sloped (maximum 2:1 gradient) and back-bladed, with proper drainage channels to prevent ponding of water and gully erosion. The pit is often seeded with a fall rye or timothy mixture, fertilized, and a straw mulch has been applied in areas that are steep, dry, or where topsoil is lacking. Sites have been planted to jack pine, red pine, white spruce or black spruce, depending upon soil and water table conditions in the pit area.

Experience in sand and gravel pit rehabilitation in this Region has reaffirmed the usefulness of stockpiling topsoil before extraction is carried out. Some rehabilitated pits have also been signed, or planted with screens of larger trees, in order to discourage public use, vandalism, or further extractions, and to reduce disturbance of slopes and new vegetation.

The Northern Region also has many sites where the gravel supply is located below the water table. When extraction is completed, these areas have been graded and seeded, and the pond areas have been stocked with fish. These rehabilitated pit areas also benefit wildlife. In one case, a former sand and gravel pit located near a large town is now being used for public swimming and recreation.

NORTH CENTRAL REGION

Gravel pit rehabilitation in the North Central Region is limited by the general lack of topsoil found on pit sites in the region. The majority of areas where aggregate deposits occur have no real covering of topsoil, but contain only 5 to 15 cm of humus. On stripping of the pit area, this humus is often intermixed with boulders and tree stumps. Consequently, to achieve good rehabilitation results on gravel pits in this region, it has been found that mulching is essential. It provides a source of organic matter to retain moisture for plant growth. A high nitrate fertilizer applied in combination with this mulching has been found to aid grass and plant establishment.

Because of the problem with a lack of topsoil in the North Central Region, local M.N.R. District Offices generally make it a condition of quarry permits

Figure 8. *Rehabilitation of a very stony gravel pit bank, North Central Region.*

Figure 9. *Tree planting carried out by Boy Scouts, in the "Trees for Canada" program.*

that before any sand or gravel removal takes place, all topsoil must be properly stockpiled for future rehabilitation requirements.

Before the rehabilitation of an extracted pit begins, all pit faces in this Region are sloped to a maximum gradient of 2:1. Standing trees up to 6 metres from the pit face are cut down, to minimize blowdown damage. Available topsoil is spread over the pit, and it is then seeded, fertilized, and mulched. Red and jack pine trees are planted for reforestation purposes. Many tree planting programs here have been carried out involving Junior Rangers, M.N.R. fire crews, and Boy Scouts. In past years the Boy Scouts of Canada and the "Trees for Canada" program have been very useful in assisting pit operators and the Ministry of Natural Resources in achieving good pit rehabilitation in this area of Ontario.

NORTHWESTERN REGION

Pit rehabilitation problems in the Northwestern Region are similar to those of the North Central Region; there is little topsoil covering the pit sites, and the material over the aggregate deposit usually consists primarily of an organic humus layer. Rehabilitation in this Region involves the proper grading of pit slopes to a safe angle and height, and the levelling of pit floors. The area is then fertilized and seeded with a mixture of grasses and clover. Establishment of grass stands is most successful on gentler slopes, where enough organic matter is present to retain moisture and to supply nutrients for plant growth. The application of mulch and fertilizer on dry and sterile pit sites and along newly constructed road edges also improves rehabilitation success. Tree planting in pit areas is also carried out, but with mixed results where topsoil is lacking.

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

The Ministry of Transportation and Communications (M.T.C.) has acquired a broad range of experience in sand and gravel pit and roadside rehabilitation techniques throughout northern and central Ontario. Through experience and research they have developed rehabilitation techniques, seed mixtures, and fertilization levels that can successfully be applied in northern Ontario.

According to M.T.C., there are several keys to rehabilitation success on gravelly, sterile sites. Scarification of the soil surface is important, in order to provide a suitable seed bed for germination. A completely smooth or compacted surface layer will hinder germination.

The timing of seeding operations is a critical factor in stand establishment for grasses and clovers. Spring or early summer seeding (prior to June 15th) is considered best, followed by seeding in mid-August to early September. In order to allow sufficient time for plant establishment and to prevent winter kill, seeding should not be carried out late in the fall.

The inclusion of an inoculated legume in seed mixtures is important as a source of nitrogen for plant growth and development. Seeding of inoculated legumes is particularly useful, therefore, on sandy, infertile sites. Seeding with a mixture containing a legume is normally successful only in the spring and early summer months (to mid June).

In order to control erosion during initial grass and legume establishment, and to provide favourable temperature and moisture conditions for seed germination and growth, the application of straw mulch is recommended. This is especially important when a legume is used in the seed mixture. Straw is preferred over hay, as it is more effective in retaining moisture, less difficult to handle and spread, and usually contains fewer weed seeds.

Figure 10. *Ministry of Transportation and Communications site in Northwestern Ontario (same site as in Figure 2). Slopes have been graded and levelled, topsoil has been spread, and the site is ready for the application of seed, fertilizer, and mulch.*

Steps to Successful Rehabilitation in Northern Ontario

Northern Ontario is noted for its demanding climatic conditions. The average growing season for plants (mean daily temperature above 5.5°C) varies from only 150 days near Hearst and Red Lake to 190 days in the Parry Sound area. Precipitation during this period (May to September) is quite uniform across the north, averaging approximately 350 to 400 mm. The short growing season and very low winter temperatures, which in January average –13°C near Parry Sound and –26°C near Hearst and Red Lake, combine to make conditions for plant growth in the north difficult. Because of these extreme climatic conditions, along with the harsh local environment for plant growth which occurs in gravel pits, rehabilitation success in the north is dependent upon proper species selection, appropriate timing of planting operations, adequate fertilization, and a sufficient supply of organic material. The steps to a successful rehabilitation effort in northern Ontario involve the following considerations and operations (Figure 11).

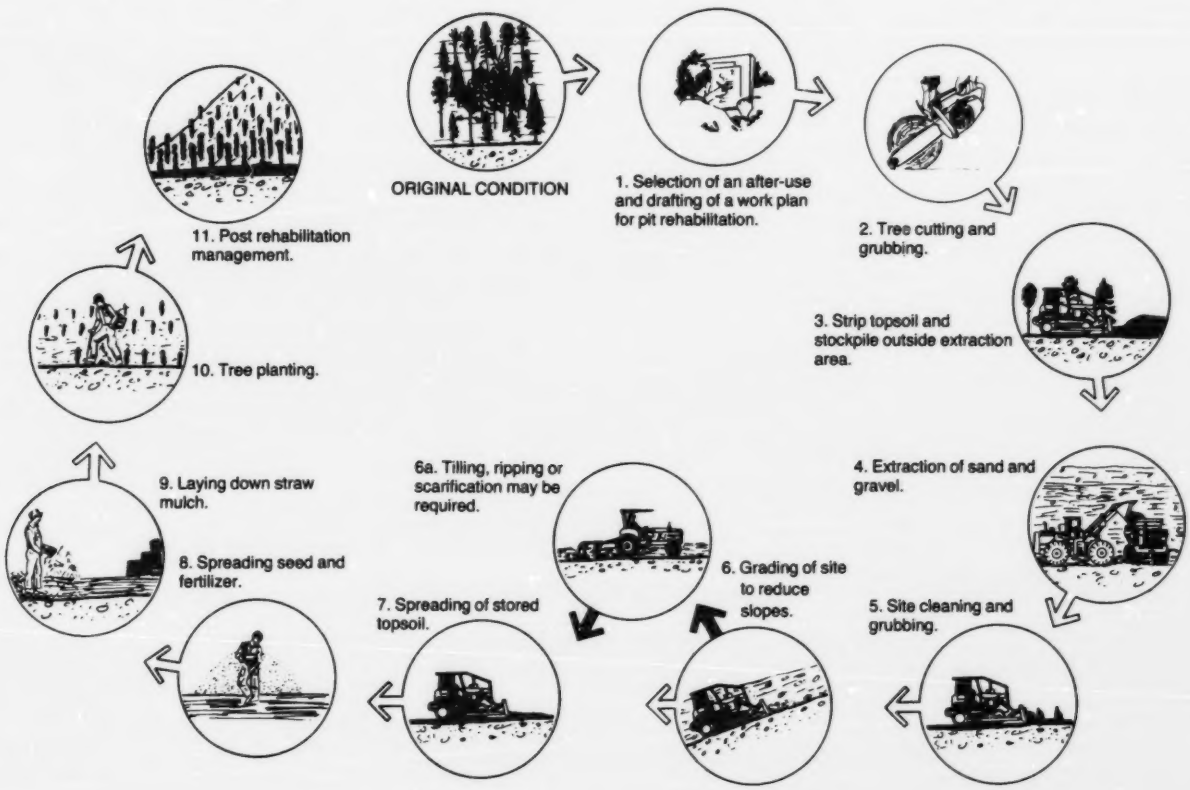
ORIGINAL CONDITION
1. Selection of an after-use and drafting of a work plan for pit rehabilitation.
2. Tree cutting and grubbing.
3. Strip topsoil and stockpile outside extraction area.
4. Extraction of sand and gravel.
5. Site cleaning and grubbing.
6. Grading of site to reduce slopes.
6a. Tilling, ripping or scarification may be required.
7. Spreading of stored topsoil.
8. Spreading seed and fertilizer.
9. Laying down straw mulch.
10. Tree planting.
11. Post rehabilitation management.

Figure 11. *Schematic diagram illustrating the rehabilitation sequence for sand and gravel pits in northern Ontario.*

• SELECTION OF AN AFTER-USE

Before any work is carried out on a sand or gravel pit, an appropriate after-use should be selected for the site, one that will be compatible with surrounding land uses. In many cases in northern Ontario, the after-use selected will be for reforestation purposes. However, other uses such as habitat for wildlife or passive recreation could be considered. In pits that will be mined below the water table, stocking of the remaining pond with fish may be possible. Any proposed gravel pit after-use should take into account the specific legislation (outlined earlier) governing the site location. It would also be wise to discuss any rehabilitation proposals with M.N.R. District Office staff.

• DRAFTING OF A WORK SKETCH OR PLAN

In order to assist in planning for and organization of a work effort directed at rehabilitation, a work sketch or plan (Figure 12) should be drawn up prior to the commencement of operations. This sketch or plan should detail all the work operations to be carried out on site, from initial clearing of the pit area to the final plantings. The plan should consider items such as the type of seeding that will be required, whether fertilizer and mulch will be used, if tree planting will be necessary, and the type of post-rehabilitation management that should be considered.

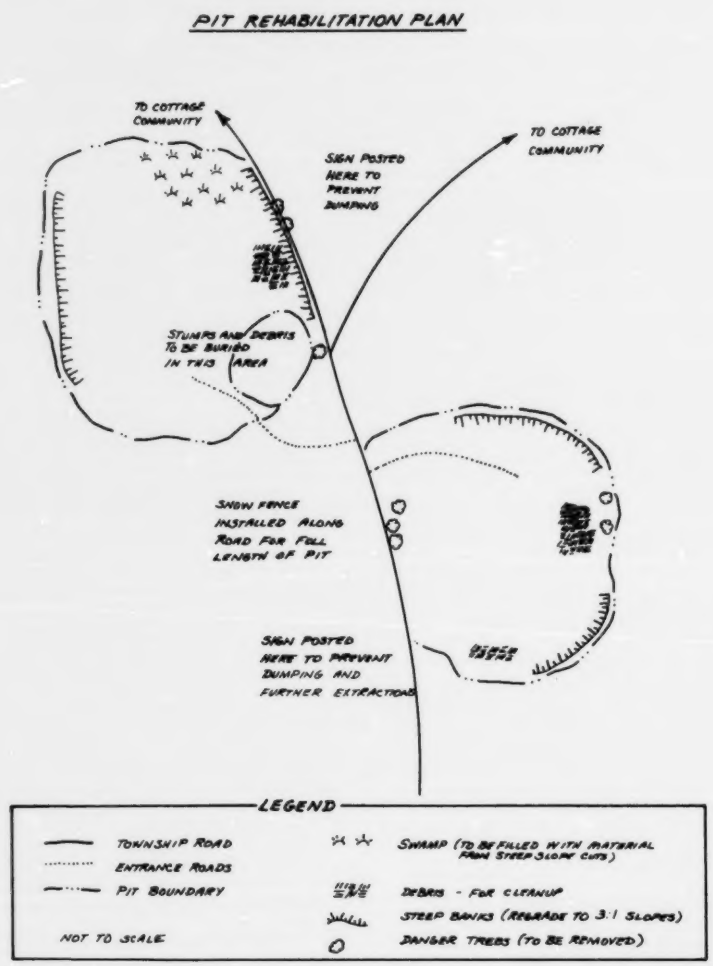
PIT REHABILITATION PLAN
TO COTTAGE COMMUNITY
TO COTTAGE COMMUNITY
SIGN POSTED HERE TO PREVENT DUMPING
STUMPS AND DEBRIS TO BE BURIED IN THIS AREA
SNOW FENCE INSTALLED ALONG ROAD FOR FULL LENGTH OF PIT
SIGN POSTED HERE TO PREVENT DUMPING AND FURTHER EXTRACTION
LEGEND
TOWNSHIP ROAD
ENTRANCE ROADS
PIT BOUNDARY
NOT TO SCALE
SWAMP (TO BE FILLED WITH MATERIAL FROM STEEP SLOPE CUTS)
DEBRIS - FOR CLEANUP
STEEP BANKS (REGRADE TO 3:1 SLOPES)
DANGER TREES (TO BE REMOVED)

Figure 12. *Sample work sketch or plan.*

• STRIPPING AND STOCKPILING OF TOPSOIL

The most important step in any rehabilitation program in northern Ontario must begin before any sand or gravel is extracted from a pit area. Prior to the commencement of aggregate extraction, trees will be cut and the site will be cleared and grubbed. Then all topsoil located in the pit area should be carefully stripped from the site, avoiding mixing with trees and boulders, and should be stockpiled in berms located outside the boundaries of the proposed extraction. Ideally, topsoil should not be worked when wet, and prolonged storage should be avoided. In this way the valuable topsoil, an ideal medium for plant growth, will become available for rehabilitation purposes at the site as extraction ceases.

Topsoil in northern Ontario can include a surface duff or humus layer, and the organic surface mineral soil layers. These mineral soil layers can include a black humic soil horizon, a whitish, bleached, mineral horizon, and/or a brownish subsoil layer.

Figure 13. *Once slopes have been graded and levelled, stored topsoil should be spread back over the area that is to be rehabilitated.*

• SITE CLEANING AND REMOVALS

Many gravel pits in need of rehabilitation contain extraneous materials, such as tree stumps, branches, and boulders, on the surface of the extracted area. This material should be gathered together and disposed of in a safe manner (e.g. burying) before rehabilitation gets under way. In order to prevent future contamination of the site, all fallen trees at the edges of the pit, and other trees in the area that are unstable and likely to blow down, should be cut and properly disposed of.

• SITE GRADING

The local environment in unrehabilitated gravel pits is usually quite detrimental to plant growth. Lack of topsoil, combined with uneven and often quite steep slopes hinders plant germination and establishment. The latter can be corrected by the regrading of the entire pit area to slopes not exceeding a gradient of 2:1, and preferably to grades of 3:1 or less (Figure 14). While the pit slopes are being graded, care must be taken to ensure proper drainage of the site. It may also be necessary at this stage, if the material on the pit floor is too compacted to support plant growth, to loosen the surface using rippers or agricultural tilling machinery. Consideration should also be given at this time to the creation of berms at the pit entrance, to screen the site and to prevent further unauthorized access.

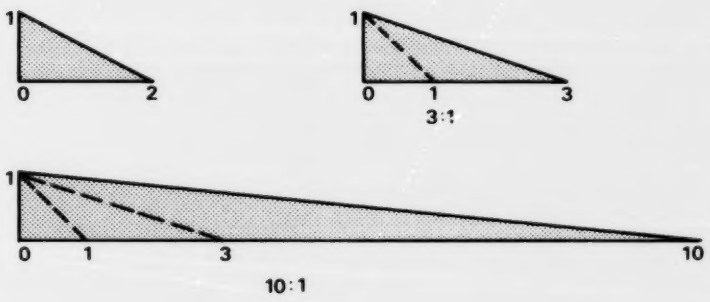

Figure 14. *Slope Gradients.*
2:1 – the maximum slope considered for long-term stability of a pit site.
3:1 – generally considered to be the maximum gradient for safe side hill vehicle travel, for effective surface erosion control and for safe pedestrian access up and down slope.
10:1 – slopes in the range of 3:1 to 10:1 are generally satisfactory for forestry, recreation and some agricultural uses.

• TIMING OF PLANTING AND SEEDING OPERATIONS

A critical component of all rehabilitation efforts in northern Ontario is the timing of the operation. The planting of a legume-based grass mixture is essential for long term erosion control and plantation success on most gravel pit sites. The season when this type of mixture is seeded is quite important. Legumes will successfully establish themselves only if they are planted in the spring, up until mid-June. If the work involved in rehabilitation has to be carried out at any other time of year, a two-stage operation should be considered. The first stage, carried out in the summer or fall, would end with the seeding of a temporary cover crop, such as oats or fall rye, to control erosion. The following spring, seeding of a grass-legume mixture can proceed, followed by tree and shrub planting, if appropriate.

• SPREADING OF STORED TOPSOIL

Once pit grading and sloping is complete, topsoil from storage berms located outside the pit area should be spread across the pit floor and sloped as evenly as possible. When this has been done, the next stage in the rehabilitation program should immediately commence, to prevent erosion and topsoil loss.

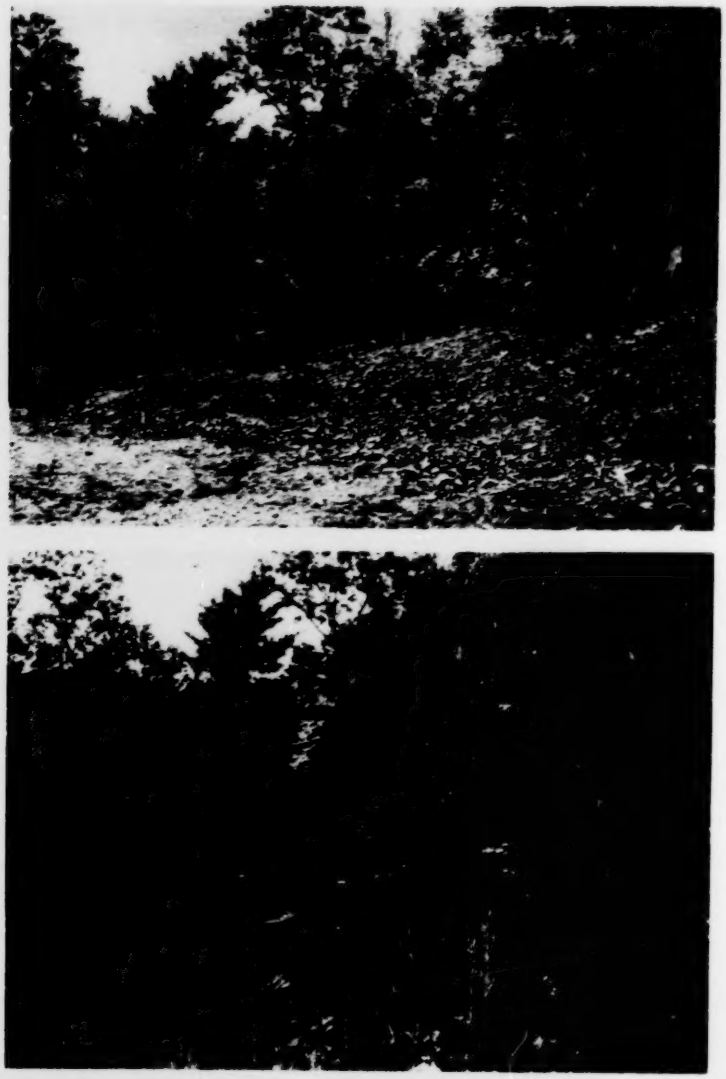

Figure 15. *A slope that is properly seeded, fertilized, mulched, and planted (upper photo), will soon produce a good quality vegetation cover (lower photo).*

• SEEDING AND FERTILIZATION OF A GROUND COVER

Seeding of a permanent ground cover will be carried out on most rehabilitated sand and gravel pit sites in northern Ontario, as an erosion control measure, to improve soil structure, and to provide organic matter so that other plant material can become established. The seed mixtures, fertilizer types, and sowing rates recommended are outlined in Appendix 2. Seed and fertilizer will generally be applied using a cyclone seeder in most parts of northern Ontario.

• MULCH APPLICATION

On most sites, a straw mulch should be applied after seeding, to control erosion while seed germination is occurring, and to provide organic matter for plant growth. When utilized, this straw mulch should be spread to a depth of between 25 to 50 mm across the treated site, or at the rate of approximately 3.5 to 4.5 tonnes per hectare.

• TREE PLANTING

In many pit rehabilitation projects in northern Ontario, the final use of the site will be a return to forestry. If this is the case, the planting of appropriate tree species may be carried out, after consultation with M.N.R. forestry staff at the local District Office. In some cases the encouragement of natural regeneration may be appropriate. The species most often used for pit rehabilitation on dry, infertile sites in the north are jack, white, and red pines, with white and black spruce being used on more fertile or wetter sites, repectively. Specific tree planting densities and stock size should be determined in consultation with M.N.R. forestry staff. Generally, 1000 to 1200 trees per hectare appears to be an appropriate planting density. The most common tree species planted in pit rehabilitation projects in the north will be available from M.N.R. nurseries (Appendix 3), with application through local M.N.R. District Offices. A guide to tree planting techniques is included in Appendix 4.

For sand and gravel pits that are being rehabilitated for the benefit of wildlife, the planting of suitable shrub species should be considered. A limited selection of species hardy in northern Ontario (see Plant Hardiness Zones Map, Appendix 5) are grown in southern Ontario nurseries, and listed in Appendix 6. An alternative to purchasing and planting nursery stock would be to find a source area of local wild shrub material, and to transplant this material to the rehabilitated gravel pit site.

• POST-REHABILITATION MANAGEMENT

When all basic rehabilitation work has been carried out, consideration may be given to fencing or screening the site to hinder unauthorized access. The planting of a screen of larger nursery stock trees blocking the access to the gravel pit site is an effective way of achieving this end. In certain areas, consideration might also be given to the placing of a sign near the rehabilitated pit entrance, so that the public is aware of the rehabilitation effort undertaken and the results achieved.

Post-rehabilitation management of the site should also include annual site visits to check on rehabilitation success, until plant establishment is assured. In areas where plantings have not been successful, remedial work should be carried out at the appropriate time in succeeding years. The rehabilitation project should not be considered complete until a strong, uniform ground cover is present, erosion is controlled, and long term successional species are well established on site.

Figure 16. *A properly rehabilitated site will require little post-rehabilitation management.*

Summary

Throughout northern Ontario, numerous sand and gravel pits have been rehabilitated to a variety of end uses, including forest production, wildlife habitat, fish production, and land- and water-based public recreational uses. The extraction of sand and gravel is viewed throughout Ontario as only a temporary use of the land, which is followed, using available technology, by after-use compatible with the surrounding landscape.

Numerous examples of good rehabilitation of sand and gravel pits are present right across northern Ontario. The restoration of these pits has involved a simple rehabilitation process, which generally includes proper site grading and drainage, spreading of stored topsoil, and the establishment of good vegetation cover to prevent soil erosion.

Prior to undertaking a pit rehabilitation project in northern Ontario, the local District Office of the Ministry of Natural Resources should be consulted, as should the appropriate municipality if the pit occurs within a municipal boundary. The Ministry office is also an excellent source of advice on seed mixtures, suitable tree species, and planting stock availability for rehabilitation projects. A listing of all M.N.R. District Offices in northern and central Ontario is contained in Appendix 7.

Appendix 1 — Selected References

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Province of Ontario
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1983: The Mining Act; Revised Statutes of Ontario, 1980, Chapter 268.

1984: The Pits and Quarries Control Act; Revised Statutes of Ontario, 1980, Chapter 378.

1985: The Environmental Protection Act; Revised Statutes of Ontario, 1980, Chapter 141, as amended by 1981, Chapter 49 and 1983, Chapter 52.

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1979: From Pits to Playgrounds: Aggregate Extraction and Pit Rehabilitation in Toronto - an Historical Review; Ontario Ministry of Natural Resources, Toronto, 51 p.

Appendix 2 — Grass Seed Mixtures and Fertilizer Levels Recommended for Sand and Gravel Pit Rehabilitation in Northern Ontario

Sandy, Infertile Sites, with Little Topsoil

Materials	Amounts to be Applied Per Hectare
Rye Grain	60 kg
Birdsfoot trefoil (inoculated seed)	32 kg
Canada bluegrass	20 kg
Tall fescue	18 kg
Creeping red fescue	10 kg
Creeping foxtail (coated)	10 kg
Hard fescue	5 kg
Alsike clover	5 kg
8-32-16 fertilizer	350 kg
0-46-0 fertilizer	200 kg
0-0-60 fertilizer	200 kg

Loamy to Clayey, More Fertile Sites

Materials	Amounts to be Applied Per Hectare
Rye grain	60 kg
Creeping red fescue	55 kg
Canada bluegrass	27 kg
Perennial rye	15 kg
White clover	3 kg
8-32-16 fertilizer	350 kg

Source: Ontario Ministry of Transportation and Communications, Maintenance Branch. For details on application, consult M.T.C.'s *Turf Establishment* manual (1986).

Appendix 3 — Suppliers of Nursery Stock

Ontario Government Tree Nurseries
Northern and Central Ontario

CHAPLEAU NURSERY
196 Cherry Street
Chapleau, Ontario
P0M 1K0
Telephone(705)864-1717

GOGAMA NURSERY
Gogama, Ontario
P0M 1W0
Telephone(705)894-2000

KIRKWOOD NURSERY
P.O. Box 310
Bare Root Building
Thessalon, Ontario
P0R 1L0
Telephone(705)842-3914

MIDHURST NURSERY
Midhurst, Ontario
L0L 1X0
Telephone(705)728-2900

SWASTIKA NURSERY
P.O. Box 129
Swastika, Ontario
P0K 1T0
Telephone(705)567-3372

THUNDER BAY NURSERY
Thunder Bay Forest Stn.
R.R. 1
Thunder Bay, Ontario
P7C 4T9
Telephone(807)939-2558

WABIGOON NURSERY
P.O. Box 90
Wabigoon, Ontario
P0V 2W0
Telephone(807)938-6326

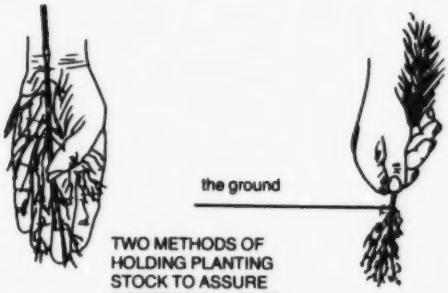
ONTARIO TREE SEED PLANT
P.O. Box 70
Angus, Ontario
L0M 1B0
Telephone(705)424-5311

Private Nurseries
Trees, Shrubs, and Ground Covers

There are numerous private growers located in southern Ontario. A listing of these growers is contained in the *Plant Source List*, available for a nominal fee from:

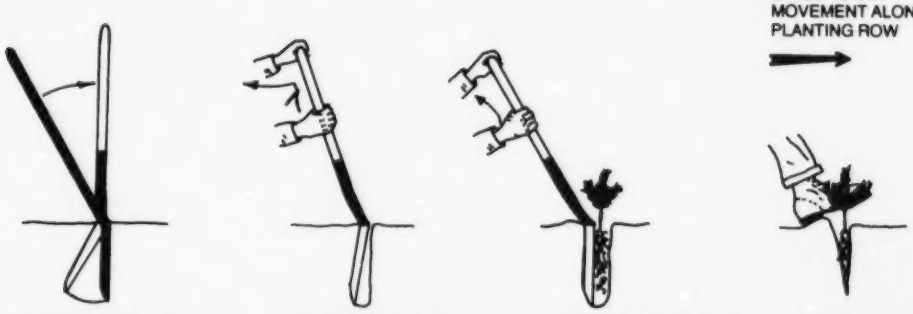
Landscape Ontario, Horticultural
Trades Association
1293 Matheson Blvd.
Mississauga, Ontario
L4W 1R1
Telephone(416)629-1184

Appendix 4 — Tree Planting Methods For Nursery Stock



TWO METHODS OF HOLDING PLANTING STOCK TO ASSURE CORRECT PLANTING DEPTH.

SLIT METHOD OF PLANTING FOR LARGE STOCK



1. A vertical cut is made with the shovel and the top of the handle is then pushed away from the planter.

2. Pull the shovel towards the planter with most of the effort on the lower hand.

3. The slit is held open with the shovel while the tree is inserted.

4. The soil is packed around the tree using the heel.

'L' METHOD OF PLANTING

1. Both cuts should be vertical.

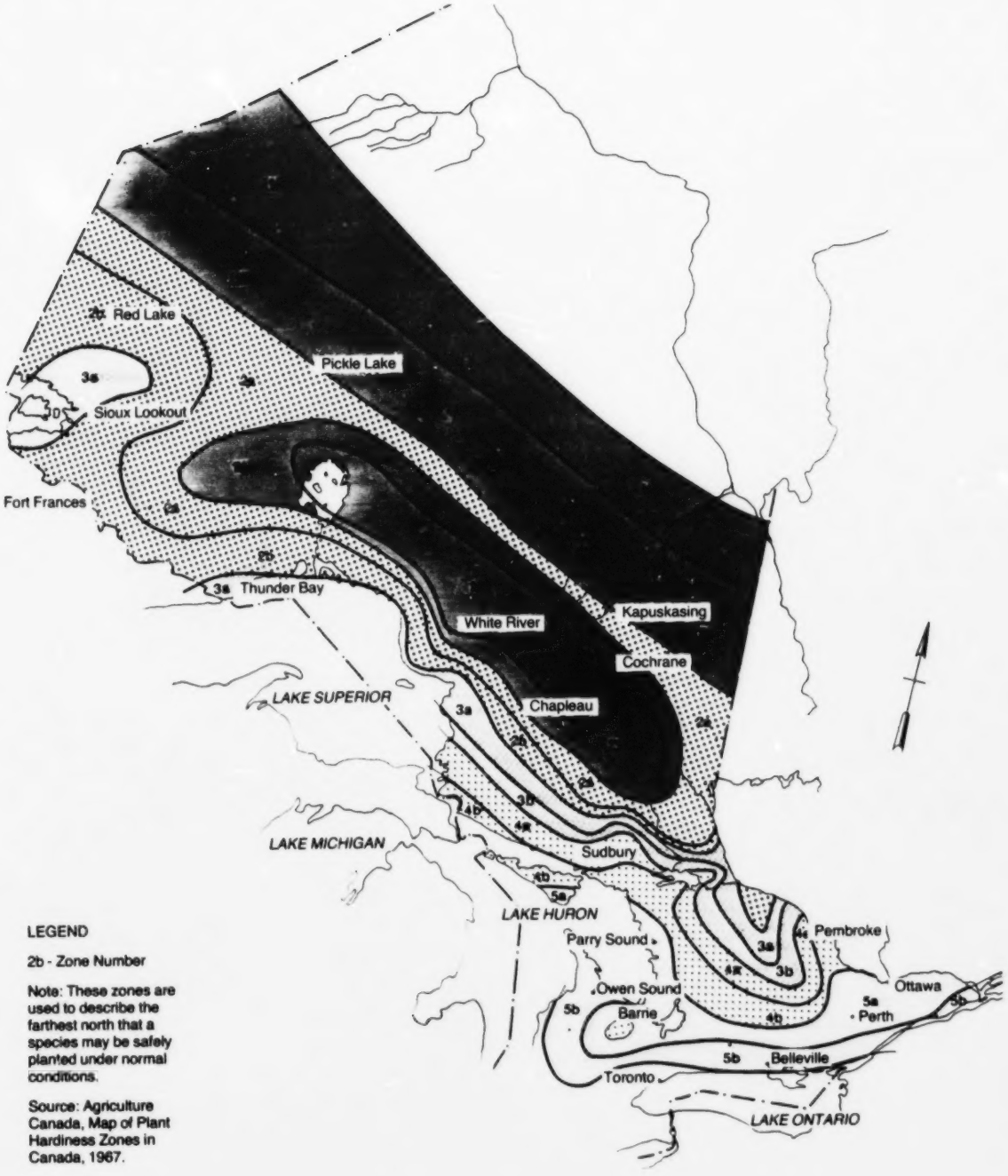
2. Soil is broken open by rocking shovel in second cut position in the line of least resistance. Soil is lifted by knee and hand pressure low on the shovel.

3. Tree is drawn under shovel blade from A to B or B to A and roots are shaken down until fully extended.

4. Shovel is removed and tree packed with heel in line of L.

Source: Ontario Ministry of Natural Resources, 1980. *Forest Tree Planting.*

Appendix 5 — Map of Plant Hardiness Zones



Appendix 6 — Shrubs Suitable For Planting In Northern Ontario

Species	Grows as Far North As Zone *
Acer pensylvanicum (Striped maple, moosewood)	4a
Acer spicatum (Mountain maple)	2
Amelanchier alnifolia (Saskatoon serviceberry)	1
Amelanchier canadensis (Shadblow serviceberry)	4
Cornus alternifolia (Pagoda dogwood)	4b
Cornus racemosa (Grey dogwood)	2b
Cornus sericea (Red osier dogwood)	2
Hamamelis virginiana (Witch hazel)	4b
Prunus pensylvanica (Pin cherry)	1
Prunus virginiana (Choke cherry)	3
Rhus typhina (Staghorn sumac)	3
Rosa rubrifolia (Redleaf rose)	2b
Salix caprea (Pussy willow)	4b
Salix purpurea (Arctic willow)	2b
Symphoricarpos albus (Snowberry)	2
Viburnum lantana (Wayfaringtree)	2b
Viburnum lentago (Nannyberry)	2

*Refer to Plant Hardiness Zones Map, Appendix 5.

Appendix 7 — Ministry of Natural Resources District Offices Northern and Central Ontario

Northern Region

Regional Office
140 4th Avenue
Cochrane, Ontario
P0L 1C0
Telephone(705)272-7011

Hearst District
631 Front Street
P.O. Box 670
Hearst, Ontario
P0L 1N0
Telephone(705)362-4346

Moosonee District
Revillion Road
P.O. Box 190
Moosonee, Ontario
P0L 1Y0
Telephone(705)336-2987

Kirkland Lake District
P.O. Box 129
Swastika, Ontario
P0K 1T0
Telephone(705)642-3222

Gogama District
Low Avenue
P.O. Box 129
Gogama, Ontario
P0M 1W0
Telephone(705)894-2000

Kapuskasing District
6-8-10 Government Road
Kapuskasing, Ontario
P5N 2W4
Telephone(705)335-6191

Cochrane District
2 Third Avenue
P.O. Box 730
Cochrane, Ontario
Telephone(705)272-4365

Timmins District
896 Riverside Drive
Timmins, Ontario
P4N 3W2
Telephone(705)267-7951

Chapleau District
190-192 Cherry Street
Chapleau, Ontario
P0M 1K0
Telephone(705)864-1710

Northeastern Region

Regional Office
199 Larch Street
Sudbury, Ontario
P3E 5P9
Telephone(705)675-4120

Wawa District
22 Mission Road
P.O. Box 1160
Wawa, Ontario
P0S 1K0
Telephone(705)856-2396

Blind River District
62 Queen Street
Blind River, Ontario
P0R 1B0
Telephone(705)356-2234

Sudbury District
Provincial Government Rd.
P.O. Box 3500, Stn. "A"
Sudbury, Ontario
P3A 4S2
Telephone(705)522-7823

North Bay District
R.R. #3, Highway 63
P.O. Box 3070
North Bay, Ontario
P1B 8K7
Telephone(705)474-5550

Sault Ste. Marie District
875 Queen Street East
Sault Ste. Marie, Ontario
P6A 5L5
Telephone(705)949-1231

Espanola District
148 Fleming Street
P.O. Box 1340
Espanola, Ontario
P0H 2H0
Telephone(705)869-1330

Temagami District
Lakeshore Drive
P.O. Box 38
Temagami, Ontario
P0H 2H0
Telephone(705)569-3622

North Central Region

Regional Office
435 James Street South
P.O. Box 5000
Thunder Bay, Ontario
P7C 5G6
Telephone(705)475-1321

Atikokan District
108 Saturn Avenue
Atikokan, Ontario
P0T 1C0
Telephone(807)597-6971

Nipigon District
Hwy. 17, P.O. Box 970
Nipigon, Ontario
P0T 2J0
Telephone(807)887-2120

Terrace Bay District
P.O. Box 280
Terrace Bay, Ontario
P0T 2W0
Telephone(807)825-3205

Thunder Bay District
435 James Street South
Thunder Bay, Ontario
P7C 5G6
Telephone(807)475-1511

Geraldton District
208 Beamish Avenue West
P.O. Box 640
Geraldton, Ontario
P0T 1M0
Telephone(807)854-1030

Northwestern Region

Regional Office
810 Robertson Street
P.O. Box 5160
Kenora, Ontario
P9N 3X9
Telephone(807)468-3111

Red Lake District
P.O. Box 5003, Hwy. 105
Red Lake, Ontario
P0V 2M0
Telephone(807)727-2253

Dryden District
479 Government Road
P.O. Box 730
Dryden, Ontario
P8N 2Z4
Telephone(807)223-3341

Fort Frances District
922 Scott Street
Fort Frances, Ontario
P9A 1J4
Telephone(807)274-5337

Kenora District
808 Robertson Street
P.O. Box 5080
Kenora, Ontario
P9N 3X9
Telephone(807)468-9841

Sioux Lookout District
Prince Street
P.O. Box 309
Sioux Lookout, Ontario
P0V 2T0
Telephone(807)737-1140

Ignace District
Hwy. 599, P.O. Box 448
Ignace, Ontario
P0T 1T0
Telephone(807)934-2233

Algonquin Region

Regional Office
Brendale Square
P.O. Box 9000
Huntsville, Ontario
P0A 1K0
Telephone(705)789-9611

Algonquin Park District
P.O. Box 219
Whitney, Ontario
K0J 2M0
Telephone(613)637-2780

Bracebridge District
P.O. Box 1138
Bracebridge, Ontario
P0B 1C0
Telephone(705)645-8747

Parry Sound District
4 Miller Street
Parry Sound, Ontario
P2A 1S8
Telephone(705)746-4201

Bancroft District
P.O. Box 500, Hwy. 28
Bancroft, Ontario
K0L 1C0
Telephone(613)332-3940

Minden District
Minden, Ontario
K0M 2K0
Telephone(705)286-1521

Pembroke District
P.O. Box 220
Riverside Drive
Pembroke, Ontario
K8A 6X4
Telephone(613)732-3661

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Figures 2 & 10: M.N.R., Atikokan District

Figure 1: M.N.R., Sudbury District

Figures 6 & 13: M.N.R., Sault Ste. Marie District

Figure 7: M.N.R., Hearst District

Figures 8 & 9: M.N.R., Thunder Bay District